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THE NEW HYDROGEN[1]

By the LORD RUTHERFORD OF NELSON

CAVENDISH PROFESSOR OF EXPERIMENTAL PHYSICS, UNIVERSITY OF CAMBRIDGE
PROFESSOR OF NATURAL PHILOSOPHY, THE ROYAL INSTITUTION, LONDON

FOR more than a century scientific men believed with confidence that pure water was a well-defined chemical substance, H_2O, of molecular weight 18. This belief was shown by the fact that the unit of mass, the kilogram, consisting of a cylinder of platinum-iridium, was initially chosen to be of the same mass as 1,000 cubic centimeters of water at the temperature of maximum density. Subsequent measurements showed that this was slightly in error, so that the unit of mass was defined in terms of the metal standard. It was only about four years ago that this confidence was disturbed as a result of the study of the isotopic constitution of oxygen. Instead of being a simple element of mass 16, oxygen was found to contain in small quantity isotopes of masses 17 and 18. It was clear from this that pure water must contain some molecules of weight 19 and 20 as well as the normal 18. Since, however, it seemed very unlikely that the proportion of the isotopes could be sensibly changed in the processes of preparation of pure water, this result, while of much theoretical interest, did not appear to have any practical importance.

As a result of investigations during the last two years, there has been a revolutionary change in our ideas of the constancy of the constitution of water. This has resulted from the discovery that a hydrogen isotope of twice the normal mass is always present in preparations of ordinary hydrogen. While this isotope of mass 2 exists only in small proportion, about 1 in 6,000 of the main isotope of mass 1, yet, on ac-

[1] Lecture before the Royal Institution of Great Britain, March 23, 1934.

count of the marked difference in mass of the two components, the relative concentration of the two isotopes can be varied in a marked way by various physical and chemical processes. This is seen by the fact that we are now able to obtain preparations of water in which the isotope of hydrogen of mass 1 is completely replaced by the isotope of mass 2. The density of this heavy water is about 10 per cent. greater than ordinary water; while its freezing point is 3.8° C., and its boiling point 1.42° C. higher. While in outward appearance this heavy water resembles ordinary water, yet in general its physical and chemical properties show marked differences. Not only does the vapor pressure vary markedly from the normal, but the latent heat is considerably higher. Both the surface tension and specific inductive capacity are lower, while the viscosity is much greater.

It is of interest to indicate briefly the almost romantic history of this rapid advance in knowledge, and to note that there are certain points of analogy between the discovery of heavy hydrogen and the discovery of argon in the atmosphere by the late Lord Rayleigh. In both cases the clue to the discovery depended on the recognition of the importance of small differences observed in accurate measurements of density.

When the relative abundance of the isotopes of oxygen was first measured, Birge and Mendel showed that there was a slight discrepancy—only about 1 in 5,000—between the ratio of the masses of the atoms of hydrogen and oxygen, measured by Aston using the method of positive rays, and the ratio deduced by direct chemical methods. They concluded that this small difference was greater than the probable experimental error in the measurements, and in explanation suggested that hydrogen might contain in small quantity—about 1 in 4,000—an isotope of mass 2. Let us consider for a moment how the presence of such an isotope could be demonstrated by direct experiment. Both the H^1 and H^2 isotopes would have the same nuclear charge of 1, and have one external electron, and would thus be expected to give the same type of optical spectrum under the influence of the electric discharge. It is to be remembered, however, that the electron, whose movements when disturbed give rise to its characteristic radiations, is coupled to the nucleus and that the rates of vibration, although mainly governed by the nuclear charge, are slightly affected by the mass of the nucleus itself. On account of the greater mass of the H^2 isotope, it can be readily calculated that the Balmer lines in the spectrum of heavy hydrogen should appear slightly displaced towards the red. In the case of the α line, the displacement amounts to 1.78 Angström units. When an electric discharge is passed through ordinary hydrogen, weak satellites should thus appear on the side towards the red. The presence of such weak satellites in the right position was first detected in experiments made for the purpose by Urey, Brickwedde and Murphy. The intensity of the satellite compared with the strong H_α line was difficult to measure with certainty but was found to be of the order of 1 to 5,000. Experiments were then made to enrich the H^2 isotope by fractional distillation of liquid hydrogen and with some success. Another important observation was made by Urey and Washburn, who found that the water in old electrolytic cells contained a larger proportion of heavy hydrogen than the normal. The concentration of H^2 was found to be rapidly enriched by continued electrolysis. This gave the key to a successful method of obtaining heavy hydrogen in quantity. The processes involved were carefully investigated by Lewis and Macdonald, who carried out the electrolysis of water on a comparatively large scale. Nickel electrodes were used, with sodium hydroxide as an electrolyte. In general, it was found that the escape of H^1 during electrolysis was from 5 to 6 times faster than that of H^2 relative to their concentrations in the solution. There was in consequence a steady accumulation of the heavy isotope in the water in the process until nearly pure heavy water was obtained. Assuming that the initial concentration of H^2 in the water was 1 in 6,000, about 1 cc of pure heavy water should be obtained by electrolysis of 6 liters of water.

Lewis succeeded in preparing many cubic centimeters of heavy water in which ordinary hydrogen was present in very small quantity, and with his collaborators investigated the main physical and chemical differences between heavy water and ordinary water, to some of which I have already referred. Our congratulations are due to our American colleagues for the masterly way they have opened up and developed so rapidly this new field of knowledge, which will certainly prove of great scientific and practical importance in many directions in the near future. Professor G. N. Lewis, of the University of California, who was the first to prepare nearly pure heavy water, generously presented samples of this water to a number of investigators, not only in his own country but in Europe, in order to give them an early opportunity of testing its properties. I am personally much indebted to him for a sample of this heavy water with which we were able to make a number of experiments on the transformation of matter to which I shall refer later.

We are all aware of the important part that hydrogen plays in many chemical compounds and particularly in organic molecules. When reasonable supplies of heavy water are available to the experimenter, there will no doubt be great activity in pre-

paring and studying many compounds in which H^1 in the molecule is wholly or partly replaced by H^2. Already a few investigations have been carried out, for example, with ammonia and with hydrogen iodide in which H^1 is replaced by the heavy isotope. It has been found that in mixtures of light and heavy hydrogen gas, the atoms interchange on a nickel surface at a temperature of about 600° C., and the conditions of equilibrium and heat evolution have been investigated. During the next few years we may expect an intensive study to be made of the change of properties of compounds in which heavy hydrogen is used. It will be of particular interest to examine the changes in the rates of reaction at different temperatures when heavy hydrogen is substituted for ordinary hydrogen.

The discovery of the new water will be of great importance in another direction, *viz.*, its effect on the processes occurring in animal and plant life. There has not yet been sufficient time to make more than a few preliminary experiments in this field, and then only on a small scale. Lewis finds that seeds of a certain tobacco plant did not germinate in pure heavy water but did so when the concentration of heavy hydrogen was about one half. In experiments by other observers, well-defined physiological effects have been obtained for quite small concentrations of heavy hydrogen in water. Further observations in this highly important field of inquiry will be awaited with much interest.

It is generally recognized that the new hydrogen will prove of so much general importance to chemistry and physics that it is desirable to give it a definite name and symbol. Professor Urey, its discoverer, has suggested that the isotope of mass 1 should be called "protium" and the isotope of mass 2 "deuterium"; while the nucleus of heavy hydrogen, which has already been found very efficient as a projectile in transforming matter, should be called "deuteron" or "deuton." The question of a suitable nomenclature is one of general importance to scientific men and deserves careful consideration. The name diplogen (διπλονς, double) for H^2 and diplon for the nucleus seemed to find some favor in England as an alternative. The symbol D for the heavy isotope seems appropriate.

While diplogen (or deuterium) may be separated in quantity from heavy water in nearly a pure state, it is of interest to refer to another method of separation employed by Hertz. By utilizing a special diffusion method devised by him, he has been able to separate from ordinary hydrogen gas about 1 cc of diplogen in such purity that the Balmer lines of hydrogen were not visible in its spectrum. With such pure material, it should be possible to study in detail the complicated band spectrum of diplogen and compare it with that of hydrogen.

We have not so far considered the question of the nuclear structure of diplogen and its relation, if any, to that of ordinary hydrogen. We first of all require to know its mass with accuracy; this has been measured by Bainbridge, using a modification of the positive ray method, who found that the mass of the atom is 2.0136 while the mass of the hydrogen atom is 1.0078 in terms of the mass of the isotope of oxygen taken as 16. This mass is slightly less than the combined mass of two H atoms. Sufficient evidence is not yet available to decide whether the D nucleus is simple or composite, and there are a number of possible combinations to consider between the four units, the electron, positron, neutron and proton. If we assume, as seems not unlikely, that the D nucleus consists of a close combination of a proton with a neutron, it can be shown from the masses concerned that its binding energy should be somewhat less than 1 million volts, if we take the value 1.0067 for the mass of the neutron as estimated by Chadwick. If this be the case, we should expect the diplon to be broken up occasionally into a proton and neutron as a consequence of a close collision with a fast α-particle. Experiments to test this have so far yielded negative results. If this dissociation occurs at all, the probability of such an event must be very small. Lawrence, from a study of the bombardment of elements by diplons, suggests that the diplon may break up into a proton and neutron in the strong electric field close to the bombarded nucleus, but the interpretation of his results is not yet certain. At the moment, therefore, the experimental evidence is insufficient to give a definite decision with regard to the structure of the diplon.

By comparing the scattering of α-particles when passing through diplogen and hydrogen gas, Mr. Kempton and I have found that as the result of a head-on collision with an α-particle, the recoiling diplon travels about 8 per cent. farther than the proton in a corresponding collision. Such a result is in agreement with calculation. It also seems clear that the field of force round the diplon must be very similar to that of the proton, although it may be expected that some differences would be shown for very fast α-particles if the diplon is composite as we have supposed.

Transmutation of Elements

The discovery of heavy hydrogen has provided us with a new form of projectile which has proved markedly efficient in disintegrating a number of light elements in novel ways. It was a very fortunate coincidence that when Professor Lewis had prepared

some concentrated diplogen, his colleague in the same university, Professor Lawrence, had available his ingenious apparatus for producing high-speed protons and other particles with an energy as high as two million volts. When diplogen was substituted for hydrogen, the diplon (D^+) was found to be about 10 times as efficient in promoting some transformations in lithium as H^+ of equal energy. It will be remembered that two years ago Cockroft and Walton[2] found that lithium when bombarded with fast protons was transformed with the emission of swift α-particles. It seems clear that in this case the lithium isotope of mass 7 is involved. A proton is captured by the nucleus and the resulting nucleus breaks up into two α-particles, ejected in nearly opposite directions according to the relation

$$Li_3^7 + H_1^1 \rightarrow He_2^4 + He_2^4$$

The emission of other particles of short range has also been observed, but the exact nature of the transformation which gives rise to them is not yet clear.

When lithium is bombarded with diplons instead of protons, different types of transformation occur. In one case it seems the lithium isotope of mass 6, after capturing a diplon, breaks up into two α-particles according to the equation

$$Li_3^6 + D_1^2 \rightarrow He_2^4 + He_2^4$$

In this case also, as has been shown beautifully by the expansion photographs obtained by Dee and Walton,[3] the two α-particles are shot out in opposite directions and with a speed greater than the swiftest α-particle from radioactive substances.

Still another interesting type of complex transformation occurs in this element. Oliphant and Rutherford[4] observed that lithium when bombarded by diplons gave, in addition to the group of fast α-particles first observed by Lawrence, a distribution of α-particles of all ranges from 7.8 cms to 1 cm in air. It is believed in this case that the isotope of mass 7 captures a diplon and then breaks up into two α-particles and a neutron according to the relation

$$Li_3^7 + D_1^2 \rightarrow He_2^4 + He_2^4 + n_0^1$$

This transformation is in close accord with the conservation of energy when the change of mass and the energies of the expelled particles are taken into account. The emission of neutrons from lithium has been observed by Lauritsen and also in our experiments. In addition, Lawrence has shown that a number of other light elements give rise under bombardment to groups of fast protons and in many cases also to α-particles and neutrons. While the interpretation of the experimental results is as yet only clear in a few cases, there can be no doubt that the use of heavy hydrogen will prove invaluable for extending our knowledge of transformations and thus in helping to throw light on the structure of atomic nuclei.

The importance of this new projectile in studying transformations is well illustrated by some recent experiments made in Cambridge by Oliphant and Harteck.[5] When diplons were used to bombard compounds like ammonium chloride, NH_4Cl, and ammonium sulfate, $(NH_4)_2SO_4$, in which ordinary hydrogen was in part displaced by diplogen, enormous numbers of fast protons were found to be emitted, even for an accelerating voltage of 100,000 volts. In fact the number of expelled particles is far greater than that observed in any other type of transformation at this voltage. The main groups of expelled protons had a range in air of 14 cms, corresponding to an energy of 3 million volts. In addition to this group, another strong group of singly charged particles of range in air only 1.6 cms was observed. Both of these groups contain equal numbers of particles. In order to account for these observations, it seems likely that, as the result of a close collision, the diplon occasionally unites with the struck diplon to form a helium nucleus of mass 4 and charge 2, but containing a large excess of energy over the normal helium nucleus. The new nucleus is in consequence explosive and breaks up into two parts, one a fast proton and the other a new isotope of hydrogen H_1^3 of mass 3. If this be the case, the proton and H^3 nucleus should fly apart in opposite directions. It can be simply calculated that the range of the recoiling H^3 nucleus under these conditions should be 1.7 cm—a range agreeing closely with that actually observed. The changes occurring are illustrated by the equation

$$D_1^2 + D_1^2 \rightarrow He_2^4 \rightarrow H_1^3 + H_1^1$$

From the known masses of D and H^1 and the energy of the observed motion of the H^1 and H^3 particles, it can be deduced that the mass of this new hydrogen isotope is 3.0151.

In these experiments large numbers of neutrons are also emitted. It appears probable that these arise from another mode of disintegration of the newly formed helium nucleus according to the relation

$$D_1^2 + D_1^2 \rightarrow He_2^4 \rightarrow He_2^3 + \text{neutron}$$

an isotope of helium of mass 3 and a neutron being expelled in opposite directions. There is strong evidence that such an isotope of helium also appears when the lithium atom of mass 6 is bombarded by protons, and from this transformation it appears

[2] *Proc. Roy. Soc. A.* 137: 229, 1932.
[3] *Proc. Roy. Soc. A.* 141: 733, 1933.
[4] *Proc. Roy. Soc. A.* 141: 722, 1933.
[5] *Nature* 133: 413, 1934.

that the mass of this isotope is 3.0165. It is quite likely that the helium nucleus of mass 3 formed in this way is unstable and may possibly break up into H_1^3 and a positive electron. While the conclusions outlined above are to some extent provisional and require confirmation by other methods, there can be no doubt that the effects which follow the collisions of a swift diplon with another are of much importance and interest in throwing light on possible modes of formation of some of the lighter nuclei.

It is of interest to speculate why the heavy isotope of hydrogen appears in many cases far more effective for equal energies in producing transformations than the lighter isotope. On the general theory of transformation proposed some years ago by Gamow, it is to be anticipated that for equal energies of motion the diplon, on account of its heavier mass, would have a smaller chance of entering a nucleus than the swifter proton. It may be, however, that normally only a small fraction of the protons which actually enter a nucleus is able to cause a veritable transformation, the others escaping unchanged from the nucleus. On this view, the greater efficiency of the diplon in causing transformation may be due to the fact that a much larger fraction of those which enter the nucleus are retained by it, leading to a violent disintegration of its structure. It may be too that the diplon on entering a nucleus breaks up into its component parts. The appearance of the proton as well as the neutron in some of the transformations may be connected with the composite structure of the diplon.

In this address I have endeavored to give in a simple way an account of our knowledge of heavy hydrogen which has been gained in the past year and to indicate the great importance of this discovery to science. This new hydrogen will undoubtedly prove of great value in many ways to physics and chemistry and probably also to the biological sciences. There are already indications that much interesting information may be obtained by the application of this new substance to the study of processes in animal and plant life.

In the course of the lecture, experiments were shown to illustrate the differences in freezing point and in vapor pressure between ordinary and heavy water, and the differences in heat conductivity between ordinary and heavy hydrogen. For the first time experiments were made to show the artificial transformation of lithium by protons and diplons of energy corresponding to about 100,000 volts. The enormous emission of fast protons when ammonium sulfate containing heavy hydrogen was bombarded by diplons was clearly shown by counting methods. The transformation apparatus was designed and operated by Dr. Oliphant, while Messrs. Watson and Sons loaned an installation to provide a steady potential of 100,000 volts to accelerate the ions.

OBITUARY

GEORGE CARY COMSTOCK

WHEN a man maintains his strength and his faculties unimpaired up to the age of nearly fourscore, and then is taken suddenly with no long drawn-out illness, we feel that his life was arranged about right. George Cary Comstock was born in Madison, Wisconsin, on February 12, 1855, and died in the city of his birth on May 11, 1934. Thus closed a career which for long was associated with the old-time "astronomy of precision."

Comstock spent his youth and prepared for college in the state of Michigan. Entering the university at Ann Arbor, he took a scientific course and was graduated in 1877. While at Michigan he came under the tutelage of Professor James Craig Watson, who was to influence his whole later life. It was in 1854 that the German astronomer Francis Brünnow was called to Michigan. Trained in the traditions of his home institutions Brünnow carried to a mid-western college the methods of a German university, and lectured in broken English to diminishing classes until Watson was his only student. Yet there were developed by Watson, who ultimately succeeded Brünnow, and the others at Michigan perhaps half of the trained astronomers of America during the seventies and eighties, and one of the foremost of the group was Comstock. After several years as a civil engineer it was in 1881 that Comstock followed Watson to Wisconsin to be assistant in the Washburn Observatory. Then, after Watson's premature death, Comstock served at Madison under Edward S. Holden, later the first director of the Lick Observatory. As a career in astronomy involved considerable uncertainty, Comstock devoted his spare time to the study of law; he was graduated from the Wisconsin law school in 1883, but he never practiced. Nevertheless, he later often referred to his legal training as possibly the most valuable part of his education.

At the age of thirty he was definitely committed to an academic career by an opening at Ohio State University, where he served as professor of mathematics for two years. In 1887 when Holden left to take up active service at the Lick Observatory it was President T. C. Chamberlin who called Comstock to take charge of the Washburn Observatory. Watson and Holden had already given it a place of distinction

in their science quite beyond that which would ordinarily be reached by a small observatory, and during the following thirty-five years Comstock maintained the quality of its work, both as its principal observer and as its administrator.

Throughout his scientific activity Comstock held an unusually happy balance between theory and practise. Though the observational astronomy of his early days consisted essentially of the visual measurement of angles he never became a routine observer. As a substitute for the meridian circle he adopted Loewy's method of placing a prism in front of a telescope, and by observing simultaneously stars separated by arcs of 120° the measures could be carried round the sphere in three steps, with the advantage that the quantities actually measured were small angles rather than large ones. From this work there resulted one of the best determinations of the constant of aberration ever made.

Comstock developed a simple formula for the amount of the atmospheric refraction which replaces in many cases the complicated procedure necessary for its evaluation. His measures of double stars were continued more than thirty years; the quality of his observations was always of the highest, exemplifying the statement that "the precision of a double-star measure bears no direct relation to the size of the telescope with which it is made." He contributed new methods of determining binary orbits, but the chief outcome of the double-star work was the detection of proper motions of faint stars. One high authority on double stars had stated that there was yet to be brought forth any evidence of the proper motion of a really faint star, but Comstock demonstrated that stars as faint as the twelfth magnitude do move enough to be detected. By the remeasurement of faint companions of bright double stars, observed incidentally by the Struves and others early in the nineteenth century, he found that, when the known motions of the bright stars were allowed for, the remaining discrepancies were due to the motions of the faint ones. This conclusion was confirmed by a determination of the sun's way from the motions of the faint stars alone. From the average apparent motion of these stars, some five or six times fainter than had been previously studied, it was evident that they were nearer to us than would be inferred from their apparent brightness. Comstock gave two alternatives —either there is an appreciable absorption of light in space or the stars which he studied are intrinsically fainter than the bright ones. The second alternative has turned out to be the correct one, and the great preponderance of stars of low intrinsic luminosity in a given volume of space, which his work foreshadowed, has been amply confirmed in recent years.

Although Comstock held what was essentially a research position, he was an inspiring teacher of the few who came to study with him, due in large part to his mastery of clear and apt expression. In private conversation, in the classroom or at larger gatherings there was never any doubt of the meaning of his words, and the ease and finish of his speech was a source of constant admiration to his listeners.

One of the important measures of the first year of the administration of President Van Hise at the University of Wisconsin in 1904 was the definite organization of the graduate school. He selected Comstock to be the head of the school, and placed on him the task of working out the problems of a new division of the university, one that was growing rapidly both in size and in importance. He held this position until 1920, as chairman, director and dean; showing in it his qualities of quiet efficiency and breadth of view. He received a school without definite organization and with about 150 students; he left it fully organized for teaching and for research and with its number nearly quadrupled. The duties of the graduate school naturally interfered with his scientific work during the later years, but on relinquishing the deanship he continued active and finished and published the researches on which he had been long engaged.

Comstock received, as was his due, many honors from his fellows. He was a member of the National Academy of Sciences and of numerous other societies in this country and abroad. He was active in the organization of the American Astronomical Society and served for ten years as its first secretary; he was later recalled from retirement to be its president.

He retired from university service in 1922 and had the happiness of twelve years of active and interested leisure; and the satisfaction of seeing the continued progress of the university and the departments with which he had been connected.

JOEL STEBBINS

SCIENTIFIC EVENTS

INTERNATIONAL CONFERENCE ON PHYSICS[1]

A MEETING of the International Union of Pure and Applied Physics will be held in October next in London and a joint conference will be held with the Physical Society, under the presidencies of Professor R. A. Millikan and Lord Rayleigh. The last meeting of the Union took place in 1931 at Brussels, when an invitation from the Royal Society to meet in London

[1] From *Nature*.

was withdrawn in order to enable the union to accept the American invitation for a meeting at Chicago at the Century of Progress Exhibition in 1933. Professor R. A. Millikan was elected president, but on account of economic conditions the meeting was cancelled and the Royal Society renewed its invitation to meet in London. The invitation was accepted and the meeting will be held from October 1 to 6. The work of the union will include consideration of the report of the Commission on Symbols, Units and Nomenclature appointed at its last meeting. The commission, under the chairmanship of Sir Richard Glazebrook, has dealt with electrical, calorimetric and thermometric units and work has also been done in connection with radiometric and acoustical units. Dr. Hales's Committee on Instruments and Instrumental Methods will, it is anticipated, desire to consult the union on a number of questions. Apart from this formal business, it was felt that the occasion should also be utilized for international discussion on a subject or subjects now attracting general interest; certain aspects of the solid state of matter were suggested as suitable.

The Physical Society had already decided to hold a Conference on Nuclear Physics and it was agreed to combine the two proposals. Thus the meeting will take the form of an International Conference, on the joint invitation of the International Union and the Physical Society, under the presidencies of Professor Millikan and Lord Rayleigh; the details are being arranged by a committee representing the two bodies. The discussion on nuclear physics will be opened by Lord Rutherford with a general survey of the subject. Subsequent papers will deal with cosmic radiation, β-ray transformation of radioactive elements, artificial transmutations by α-rays, neutrons, protons and diplons and new types of radioactivity, and the constitution of atomic nuclei. Sir William Bragg will deliver an opening survey in the discussion on the theory of the solid state of matter. Papers on interatomic forces will be divided into three groups dealing with electrovalent linkings, covalent linkings and van der Waals attractions; as special consideration will be given to the action of these forces in metals at the Aberdeen meeting of the British Association, this particular section of the subjects will not be so fully considered at this discussion. Another group of papers will deal with the possible existence of a secondary structure in crystals, coarser than the fine structure detected by x-rays, and its relation to physical properties. The names of delegates of national unions adhering to the International Union of Physics should be sent to the secretaries of the conference not later than August 1. Invitations are being sent to a number of physicists known to be interested in these subjects; others desiring to attend should send in their names not later than September 1. All communications should be addressed to the Secretaries, International Conference on Physics, Royal Society, Burlington House, London, W.1.

SOIL SURVEYS OF THE DEPARTMENT OF AGRICULTURE

ANSWERING a call for help from Puerto Rico, the U. S. Department of Agriculture has assigned eight experienced investigators from the Bureau of Chemistry and Soils and a district inspector of the Soil Survey to begin work in July mapping and classifying more than a million acres of the soils of the mountainous interior of the island. According to Dr. Henry G. Knight, chief of the bureau, the work will take ten months.

To support Puerto Rico's dense population of 450 persons to the square mile it is necessary to raise crops of high acre value and to make the best use of all lands available for crop production. The Soil Survey has already surveyed and mapped all the soils of the coastal plain parts of the island. The study of the rest of the soils is expected to mark out on the higher lands other areas that can be profitably utilized.

Soil Survey aid in meeting the problems of soil classification, for land appraisal, for locating subsistence homestead tracts, for crop acreage reduction, and for Federal and State planning, in connection with the present recovery program, emphasize the practical value of the information collected and methods that have been developed in thirty years of research carried on while completing the mapping and description of half of the agricultural area of the United States.

Dr. Knight states that the recent completion of a soil survey of McKenzie County, N. Dak., which is to serve by its exhaustive soil classification as the basis for a program of accurate land taxation inaugurated by county and state officials, has resulted in requests from the county boards of Billings and Morton Counties of that state for similar surveys with which to attack their problems of farm taxation.

The Soil Survey has been found of increasing value in solving practical problems of zoning lands into separate areas for farming, forestry and recreational uses in Wisconsin, and its maps and classification of soils in New York State have become the basis for somewhat similar activities there. Another important activity of the recovery program, for which the federal soil surveyors have recently been drafted, is the selection of productive lands for subsistence homesteads. They have already assisted in choosing thousands of acres of fertile land in several states where the new home-makers can begin farming operations with the assurance that the land will do its part.

THE SCIENTIFIC EXHIBIT AT THE CLEVELAND MEETING OF THE AMERICAN MEDICAL ASSOCIATION

THE Scientific Exhibit at the Cleveland meeting of the American Medical Association, as reported in the *Journal* of the association, was the largest in its history. All fifteen sections of the Scientific Assembly participated through special section exhibit committees appointed for the purpose, while sixty-three individuals reading papers before the various sections had exhibits on the same subjects.

There were three special exhibits authorized by the Board of Trustees. The exhibit on encephalitis, a cooperative undertaking by the Committee on Scientific Exhibit, with the United States Public Health Service, placed special stress on certain features of the 1933 outbreak; a pamphlet prepared by Theodore C. Hempelmann, St. Louis, was distributed. The committee in charge consisted of James P. Leake, Washington, D. C., Ralph S. Muckenfuss, St. Louis, and Ralph C. Williams, chairman, Washington, D. C.

The exhibit on nutrition was conducted in conjunction with the session on nutrition in the Section on Miscellaneous Topics. The exhibit, presented under the joint auspices of the Committee on Scientific Exhibit, the Committee on Foods and *Hygeia*, was under the direction of a committee composed of Walter C. Alvarez, Rochester, Minn., Reginald Fitz, Boston, and P. C. Jeans, Iowa City, assisted by a competent corps of demonstrators. A pamphlet on nutrition, prepared for the occasion, was distributed at the exhibit.

The special demonstrations in pathology were presented under the direction of Benjamin S. Kline, Cleveland, assisted by a group of local pathologists. In addition to the continuous demonstrations in the booth, practical talks were given at stated intervals.

Among the section exhibits there were several special features. The Section on Ophthalmology presented a comprehensive display on first aid in eye injuries and distributed a pamphlet on the same subject to supplement the exhibit; the Section on Obstetrics, Gynecology and Abdominal Surgery had an exhibit on home delivery technic and also showed motion pictures in an area adjoining the exhibit; the Section on Dermatology and Syphilology presented a symposium on cutaneous allergy; the Section on Practise of Medicine showed motion pictures on a prearranged schedule.

There were several symposiums to which exhibitors from different sections contributed. The symposium on the treatment of burns was a cooperative undertaking sponsored by the Section on Surgery, General and Abdominal, the Section on Practise of Medicine, and the Section on Pathology and Physiology. Besides nine exhibits dealing with various phases of the subject there was a motion-picture program shown in an adjoining area.

The symposium on amebiasis included contributions from the Section on Gastro-Enterology and Proctology, the Section on Pathology and Physiology, the Section on Pharmacology and Therapeutics, and the Section on Preventive and Industrial Medicine and Public Health.

The group of exhibits on thyroid diseases was presented through the cooperation of the Section on Practise of Medicine, the Section on Surgery, General and Abdominal, the Section on Pharmacology and Therapeutics and the Section on Pathology and Physiology.

There were 162 individual exhibits open to medal awards, nineteen educational exhibits and five special exhibits sponsored by the Committee on Scientific Exhibit or by section exhibit committees, making 186 exhibits in all. There were 364 persons identified with the various exhibits.

The awards in Class I, made for exhibits of individual investigations, which are judged on the basis of originality and excellence of presentation, were as follows:

The gold medal to Gregory Shwartzman, Mount Sinai Hospital, New York, for original investigations of skin reactivity to bacterial filtrates, its rôle in immunology and its practical applications.

The silver medal to Timothy Leary, Boston, for original work on the relation of cholesterol to atherosclerosis.

The bronze medal to Charles C. Higgins, Cleveland Clinic, Cleveland, for original work on experimental production and solution of urinary calculi.

MEMORIAL TO SIR WALTER FLETCHER

AN appeal for funds for a memorial to Sir Walter Fletcher, made in a letter signed by an influential committee, appears in English journals. The letter follows:

The public life of this country suffered a loss of more than common magnitude through the death of Sir Walter Morley Fletcher, first secretary of the Medical Research Council, on June 7, 1933. He was then in his sixtieth year and in the height of those powers which he had used without stint in the service of science and of mankind.

The ideal that he held before him, in words which were frequently upon his lips, was the advancement of knowledge for the relief of human suffering. He strove ever towards this, both in his years at Cambridge as a brilliant investigator and an influential teacher of youth, and later in the administration of the public support provided for medical research, and in measures for bringing the results of scientific work more effectively to the assistance of the state.

Walter Fletcher gave richly to the common weal, and it is proper that some worthy tribute of an enduring

kind should be paid to his memory. The desire to take part in this will be wide-spread among those who were able truly to appreciate his great labors in the cause of medical science, and will be felt not least by the many research workers who were directly indebted to him for help and inspiration; it will extend, also, to others in different spheres of life who were privileged to enjoy that friendship for which he had so great a gift, and throughout a wider circle of those who admired his vigorous personality and his mastery of practical affairs.

It is considered that the tribute should consist in the first place of a personal memorial, and secondly of the inception of some scheme for the furtherance of the cause which Sir Walter Fletcher had so much at heart. It is therefore proposed first to commission a portrait bust, to be placed in a suitable setting in the entrance hall of the National Institute for Medical Research at Hampstead. The remainder of the sum collected will then be used as a fund for building—at the farm premises of the National Institute at Mill Hill—a Walter Fletcher Laboratory, to be devoted particularly to those nutritional studies in which he was so keenly interested. This will not only provide an appropriate memorial, but it will make an urgently needed contribution to the national equipment for work in what is at present among the most important of all branches of medical research.

In view of the wide utility and public value of the second part of the memorial, it has not been thought desirable to suggest for individual subscriptions any limit such as might have been fitting for a tribute of a purely personal character. It is strongly hoped, however, that this will in no way deter those who may wish to have a share in the personal memorial but are of necessity restricted to giving quite small sums. All subscriptions should be sent to the Secretary, Fletcher Memorial Fund, 38, Old Queen Street, Westminster, S.W.1.

We are, yours faithfully,

STANLEY BALDWIN	T. R. ELLIOTT
F. G. HOPKINS	ROBERT MUIR
D'ABERNON	HARRIETTE CHICK
MILDMAY OF FLETE	G. M. TREVELYAN
C. S. SHERRINGTON	M. R. JAMES
ALAN GREGG	A. E. BOYCOTT
DAWSON OF PENN	H. H. DALE
H. T. WARING	E. MELLANBY
C. J. MARTIN	

June 7

IN HONOR OF PROFESSOR WILLIAM HERBERT HOBBS

IN accepting the resignation of Professor William Herbert Hobbs, head of the department of geology of the University of Michigan, who reached the age of seventy on July 2, the title of professor emeritus was conferred on him by the Board of Regents. The following resolution was adopted:

Resolved, That in accepting the resignation of Dr. William Herbert Hobbs as professor of geology, head of the department of geology and director of the geological laboratory, which is tendered at this time in pursuance of the By-Law governing the retirement of members of the faculty, the Regents express to Professor Hobbs their lively appreciation of his distinguished services to this university over a period of twenty-eight years, during which time his accomplishments as a teacher and his constant activity in research, publication and exploration in little-known lands have brought credit both to him and to this institution.

At the last meeting of the faculty of the College of Literature, Science and the Arts, a resolution passed in appreciation of the work of Professor Hobbs says:

This faculty is convened in appreciation of the services of Professor William Herbert Hobbs, who after twenty-eight fruitful years of scholarly activity at the University of Michigan is now retiring, full of all the honor we can best bestow upon him. If we look back over Professor Hobbs' career we can all agree that he has nobly measured up to the demands of his profession and has amply merited the title of professor, with all that it implies. Certainly, his creative scholarship, his leadership and his ability to inspire others are traits of which we have all had first-hand experience.

This profession of ours, if it makes harsh demands, seldom bestows its awards in the coin that the world recognizes. Of monetary rewards there are few enough; of fame there may be some, but too often the successful charlatan and political schemer is better known than the honest and honorable scholar. There is, however, the realization that one's colleagues know and respect one's worth; there is the affection of old students; there is the gratitude of the institution—these are all things that are not to be bought save by years of tireless devotion to an ideal. May our good colleague, Dr. Hobbs, live long to enjoy these rewards and to realize that he commands the respect and the regard of us all.

A concurrent resolution passed unanimously by the Michigan Legislature follows:

WHEREAS, Professor William Herbert Hobbs, for twenty-eight years a member of the faculty of the University of Michigan, will retire in July of this year at the age of seventy years; and,

WHEREAS, Professor Hobbs through his high academic attainments and many accomplishments in the science of geology has brought our university into front rank in the teaching of this science; and,

WHEREAS, Professor Hobbs has led expeditions into the South Sea Islands and into Greenland to further the study of natural phenomena; and

WHEREAS, Professor Hobbs lent invaluable services to the allied cause during the World War for which the Republic of France made him a Chevalier of the Legion of Honor; now, be it

Resolved, By the House of Representatives the Senate concurring, that congratulations be extended to Dr. Hobbs for his long career of usefulness and that regret be voiced for his loss to the university, and, be it further

Resolved, That a suitable copy of this resolution be transmitted to this distinguished citizen of Michigan.

SCIENTIFIC NOTES AND NEWS

MME. MARIE SKLODOWSKA CURIE, professor of physics at the Sorbonne, University of Paris, died on July 4. She was sixty-six years of age.

INCIDENT to changes in organization which are being made in the U. S. Department of Agriculture the office of director of scientific work, which has been held since 1926 by Dr. A. F. Woods, formerly president of the University of Maryland, was discontinued on June 30. Dr. Woods has been transferred to the Bureau of Plant Industry to conduct investigations relative to plant patents and to consult with the head of the division of fruit and vegetable crops and diseases on research problems in plant physiology and pathology. The Graduate School of the department, which was attached to the office of the director of scientific work, will be continued under the direction of Dr. Woods.

DR. GEORGE F. KAY has resigned from the positions of head of the department of geology, the University of Iowa, and state geologist of Iowa. These positions he has held for twenty-three years, since the death of Dr. Samuel Calvin. He will retain his administrative duties as dean of the College of Liberal Arts, member of the staff of the Geological Survey and professor of geology in the university. Dr. A. C. Trowbridge has been appointed to succeed Dean Kay in the two vacant positions. Dr. A. C. Tester has been appointed assistant state geologist to succeed Dr. James H. Lees, who resigned recently on account of ill health.

ON the retirement of Captain William J. Peters after continuous service with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington since January 1, 1906, a replica of the ship's clock formerly carried on the *Carnegie*, of which he was the first commander, was presented to him by members of the staff of the department in token of their esteem and friendship. At the presentation held on the grounds of the department on the afternoon of June 29, several of those who had served at sea with Captain Peters recounted some of their experiences on board.

AT the commencement exercises at Colgate University the degree of doctor of science was conferred on Dr. William F. Langworthy, who is retiring from the chair of botany at the university.

AT the seventy-fifth anniversary of Lake Erie College the degree of doctor of laws was conferred on Dr. Robert Sessions Woodworth, professor of psychology at Columbia University, son of Lydia Ames Sessions, the first president of Lake Erie College.

THE degree of doctor of laws was conferred on Dr. Frederick Webb Hodge, director of the Southwest Museum, Los Angeles, by the University of New Mexico at Albuquerque on June 4.

PROFESSOR RALPH E. SMITH, of the department of plant pathology of the University of California, received the honorary degree of doctor of science on the occasion of the commencement of the Massachusetts State College at Amherst.

AT the recent commencement exercises at DePauw University, the honorary degree of doctor of science was conferred upon Dr. Paul Merica, adviser to the president of the International Nickel Company, known for his researches on nickel and its alloys.

THE University of Arizona conferred upon Henry A. Wallace, Secretary of Agriculture, the honorary degree of doctor of science at the thirty-ninth annual commencement "in recognition of his scientific contributions and fearless leadership in the cause of agriculture." The same honorary degree of doctor of science was conferred upon his father, Henry Cantwell Wallace, by the University of Arizona at a special faculty convocation on March 31, 1923.

NATHANIEL KESSLER, of Newark, a member of the advisory committee of the New Jersey College of Pharmacy of Rutgers University and a special lecturer on pharmaceutical jurisprudence, has received the Rutgers University award, a bronze medal, for "generous and able service to pharmaceutical education."

THE 1934 James E. Stacy Award, consisting of a medal and a sum of money, given by the Faculty of Medicine of the University of Cincinnati for significant contribution to the theory of focal infection in theory or practise, has been bestowed upon Dr. E. R. LeCount, professor of pathology in Rush Medical College, for "his experimental studies on the isolation of streptococci from sore throats and the experimental induction, through their injection, of acute, healing and scarring types of nephritis, identical with the chronic nephritides observed in man."

SIR ARTHUR SMITH WOODWARD was elected president of the British Paleontographical Society at the eighty-seventh annual meeting.

PROFESSOR ANDREW BOSS, vice-director of the Agricultural Experiment Station at University Farm, University of Minnesota, has been elected president of the university chapter of Sigma Xi to succeed Dr. Samuel C. Lind, director of the School of Chemistry.

MISS EFFIE ISABEL RAITT, for twenty-two years director of home economics at the University of Wash-

ington, was elected president at the twenty-seventh annual conference in New York City of the American Home Economics Association in succession to Dr. Frances Zuill. Miss Mabel V. Campbell, of the University of Missouri, was elected vice-president.

PROFESSOR SOLOMON C. HOLLISTER, professor of structural engineering at Purdue University, has been appointed director of the School of Civil Engineering of Cornell University. Since the resignation three years ago of Professor Fred Asa Barnes as director, the school has been governed by a committee of which during the past year Professor Paul H. Underwood has been chairman.

DR. EDNA FRANCES HEIDBREDER, associate professor of psychology at the University of Minnesota, will become professor of psychology at Wellesley College.

PROFESSOR RICHARD COURANT, formerly director of the Mathematical Institute of the University of Göttingen, has been appointed visiting professor of mathematics at New York University. The appointment was made possible by grants from the Emergency Committee in Aid of Displaced German Scholars and the Rockefeller Foundation.

DR. F. M. MACFARLAND, of Stanford University, was elected by the council of the California Academy of Sciences on June 18 to serve as acting director of the academy and of the Steinhart Aquarium until a permanent director may be chosen. He succeeds Dr. C. E. Grunsky, who died on June 6. Dr. MacFarland retired at the close of the academic year with the title of professor emeritus of histology after serving for forty-two years.

DR. LAURENCE H. SNYDER, of the Ohio State University, has been elected chairman of the committee on human heredity of the National Research Council, succeeding Dr. Charles B. Davenport, of the Carnegie Institution.

UNDER a special appropriation made by the New York State Legislature, research on the Dutch elm disease is under way at the Cornell University Agricultural Experiment Station. The work in plant pathology will be under the direction of Dr. D. S. Welch and in entomology of Dr. P. A. Readio, who has recently terminated his appointment at the University of Kansas to accept an assistant professorship at Cornell University.

DR. HERBERT R. EDWARDS, acting health officer of New Haven since the resignation in January of Dr. John L. Rice to become health commissioner of New York City, has resigned to direct the tuberculosis program in New York. For the present a committee of the board of health will manage the activities of the department at New Haven.

DR. G. CANBY ROBINSON, director of the New York Hospital-Cornell Medical College Association, has been granted a year's leave of absence by the two institutions forming the association. During the past six years, Dr. Robinson has carried out a large undertaking of building and equipping the plant along the East River and has also directed the problems of reorganization of the New York Hospital and of the Cornell University Medical College which were necessary in bringing the two institutions into organic association.

AFTER spending a year in North Africa under a research grant from the Geological Society of America, Mr. Robert van Vleck Anderson recently returned to the United States. He has spent some weeks at the National Museum in Washington, where he has completed a memoir on the geology of some of the coastal ranges of western Algeria.

DR. B. YOUNGBLOOD, specialist in economics and sociology in the Office of Experiment Stations, U. S. Department of Agriculture, has, on request of the Secretary of the Interior, been assigned to make a study of economic and living conditions among the Navajo Indians, with a view to finding means of improving these conditions. Dr. Youngblood will devote particular attention to the trade relations of the Navajos.

DR. M. F. BARRUS, professor of plant pathology at Cornell University, sailed for Puerto Rico on June 28. He has been given two years' leave of absence to take charge of the reorganization of agricultural extension work at the Insular Experiment Station, Rio Piedras. Dr. P. P. Pirone, formerly in charge of Dutch elm disease eradication in Nassau County, Long Island, has been appointed acting extension assistant professor of plant pathology during the absence of Dr. Barrus.

DR. CHARLES H. BEST, professor of physiology and assistant professor of hygiene and preventive medicine in the University of Toronto Faculty of Medicine, gave a course of three lectures at University College, London, recently, on "Rôle of the Liver in the Metabolism of Carbohydrate and Fat."

DR. WILLIAM ALLEN PUSEY, Chicago, delivered the Prosser White Oration before the St. John's Hospital Dermatological Society, on June 27, at the Royal Society of Medicine, London. His subject was "Disease, Gadfly of the Mind, especially the Stimulus of Disease in the Development of the Mind."

A SPECIAL program of entertainment is being planned for the Sunday which is included in the dates for the winter meeting of the American Association for the Advancement of Science which will be held in

Pittsburgh from December 27 to January 2. On Sunday afternoon, December 30, Dr. Phillips Thomas, of the research department of the Westinghouse Electric and Manufacturing Company, has consented to give his lecture on "Ramblings in Research." This address is being continually revised and kept up to date so as to be illustrative of the latest developments in commercial electrical research. In the evening of the same day Dr. Marshall Bidwell, organist at the Carnegie Music Hall, will give a special recital for guests at the meeting. He will be assisted by the symphony orchestra from the department of music at the Carnegie Institute of Technology. The orchestra, consisting of some eighty musicians, will be directed by Professor J. Vick O'Brien, head of the department of music.

THE fourth Annual Economic Conference of Engineers will open on August 11 at the Stevens Institute of Technology and will continue through Sunday, August 19, during which period there will be twenty-five scheduled meetings having as their general theme "An Economic Appraisal of the New Deal." As in previous years, the conference will be held at the Stevens Engineering Camp at Johnsonburg, in northern New Jersey. This annual conference, initiated in 1931, has had as its sponsors the engineering alumni associations of Brown, Columbia, Cornell, Harvard, Massachusetts Institute of Technology, Princeton, Rensselaer, Stevens and Yale; also the American Society of Mechanical Engineers, the American Institute of Chemical Engineers and the American Association for Adult Education. Approximately one hundred graduates of twenty-eight colleges of engineering attended the conference of 1933. At the final session on Sunday evening, August 19, General Hugh S. Johnson, NRA Administrator, will speak.

THE Tri-State Field Conference of the geologists of Illinois, Iowa and Wisconsin will be held on Saturday and Sunday, October 20 and 21. The participants will assemble in Madison on the morning of October 20 and proceed from Madison to the Baraboo region. The night of October 20 will be spent in Baraboo and the party will disband at noon on October 21. The geologic section examined will extend from early pre-Cambrian to Silurian.

THE International Geographic Congress, under the auspices of the International Geographic Union, will be held in Warsaw from August 23 to 31. A series of field excursions is planned from Warsaw, both before and after the sessions. Under the direction of well-known geographers these parties will go into the field on trips of from five days to a week to study the geographical features of the country, including the Carpathian Mountains, the Vistula valley and Silesia. The executive committee of the congress has made arrangements for special fare reductions on the Polish railways and in other countries for the benefit of the delegates, free visas for entering Poland and for the entertainment of the visitors during their stay in Warsaw.

DR. J. ALLEN JOHNSON, chief electrical engineer of the Buffalo, Niagara & Eastern Power Corporation at Buffalo, N. Y., was elected president of the American Institute of Electrical Engineers for the year beginning August 1, at the annual meeting at Hot Springs, Va. The other officers elected were: *Vice-presidents,* W. H. Timbie, Cambridge, Mass.; R. H. Tapscott, New York, N. Y.; G. G. Post, Milwaukee, Wis.; F. J. Meyer, Oklahoma City, Okla.; F. O. McMillan, Corvallis, Ore.; *Directors,* F. Malcolm Farmer, New York, N. Y.; N. E. Funk, Philadelphia, Pa.; H. B. Gear, Chicago, Ill.; *National Treasurer,* W. I. Slichter (re-elected), New York, N. Y. The annual report of the Board of Directors, presented at the meeting, showed a total membership of 15,230. In addition to two national conventions and one district meeting, 1,487 meetings were held during the year by the local organizations in the principal cities and educational institutions in the United States, Canada and Mexico.

THE newly established 500-acre arboretum at Madison near the University of Wisconsin was formally dedicated recently at an early morning breakfast service held on the arboretum grounds. More than 150 citizens of the state attended. Eight speakers represented the state and the university. These were Aldo Leopold, professor of wild life management and research director of the arboretum; Professor G. W. Longenecker, executive director; Professor E. M. Gilbert, chairman of the arboretum committee; Gen. Ralph M. Immel, of the State Conservation Department; John Callahan, who read a message from President Glenn Frank; George Mead, Wisconsin Rapids, who spoke for the university regents; John Nolen, city planner, and Chief Yellow Thunder, Wisconsin Winnebago Indian.

THE Bass Biological Laboratory in Englewood, Florida, was closed on May 15 for the 1933–34 season. Two members of its staff, John F. Bass, Jr., and Donald J. Zinn, left for Denmark on June 12, to make a general survey of the commercial fisheries, to secure information for Dr. Elmer Higgins, of the U. S. Bureau of Fisheries, on the forecasting of the Danish mackerel catch, and also to verify reports of the spreading of a fatal intestinal parasite of the edible shrimp. The laboratories will reopen on October 1.

THE British Medical Research Council announces the inauguration of new arrangements for further

combined chemical and bacteriological investigations into the conditions which govern the life and multiplication of microorganisms causing disease. These have been made possible by the cooperation of the Middlesex Hospital Medical School, the trustees of the late Lord Leverhulme and the Sir Halley Stewart Trust. Accommodations and facilities are being provided at the Middlesex Hospital in the Bland-Sutton Institute of Pathology and the adjoining Courtauld Institute of Biochemistry. The investigations will be directed by Dr. Paul Fildes, who has been appointed a member of the scientific staff of the council. The other workers are Mr. B. C. J. G. Knight, with a Halley Stewart Research Fellowship, and Dr. G. P. Gladstone and Dr. G. Maxwell Richardson, holding Leverhulme Research Fellowships. The arrangements took effect on June 1, and the support given by the cooperating bodies is sufficient for an initial period of five years.

DISCUSSION

THE CRISIS AT BUITENZORG

THERE are a host of reasons that something ought to be done to prevent one of the most important institutions of learning in the Orient, the Botanical Gardens and Biological Laboratories at Buitenzorg, Java, from falling into decay as a result of lack of governmental means of support.

This institution represents a collection of information regarding tropical botany and zoology reaching back well over one hundred years.

The herbaria and the collections of living plants contain great numbers of type specimens and much data of the utmost importance, because, due to the swift changes which have taken place in the forests of Java in the last century, they have become practically irreplaceable. In them are assembled the collections of Valliton, Boerlage, Treub, Hasskarl, Kohrdes, Backer, Teysman and many others, gathered from the whole Malay archipelago, and representing species, many of which have become exceedingly rare or even extinct.

The Museum of Economic Plant Products, created by Heine, during a lifetime of extraordinary industry, is probably not equalled by any other museum in the Tropics. The data which Heine was able to get together, respecting the uses of a multitude of tropical plants by the forty or more races of people who occupy the vast archipelago, possess a value almost impossible to estimate. The collections upon which these observations were based are unique and irreplaceable.

Not only is there the superb Botanic Garden, certainly the finest in the whole world, with its many and useful laboratories, but the gorgeous Mountain Garden as well. This is situated at the very edge of the Rain Forest on the slope of the Volcano Gedeh. It has been a source of inspiration to many famous investigators of the past. Shimper, Haberlandt, Weisner, Haeckel, Zimmerman, Douglas Campbell, Goebel, De Vries and many other Europeans and Americans have felt its inspiration and have reflected it in their subsequent writings. Out of the studies of these men have come papers and books and lectures and conferences which have enlightened thousands of students as to the real nature of tropical life and its bearing upon the problems of life or peoples inhabiting the temperate zone.

It was the privilege of one of us (D. F.) to visit Java in 1895, accompanying there Melchior Treub, to whose initiative much of what now stands in the way of equipment in Buitenzorg is due, and of the other writer of this appeal to spend months in the laboratory in the garden while it was still in Treub's hands in 1906–07. The senior author has visited it twice since. If there has ever been any one period of our lives more than another that has impressed our whole outlook on science it was the period of our first stay in the Botanic Gardens of Buitenzorg.

The strictly scientific standing of the garden and all connected with it is an example to the rest of the tropical world. It was much more than a tropical botanical garden. It was then and has remained to this day one of the most remarkable scientific institutions in the world.

It is impossible to look with equanimity upon the threatening disintegration of such an institution, more than ever when certain problems of the tropics are pressing for solution. The growth of our knowledge of the science of genetics, and the bearing of that science upon the whole intricate problem of evolution, make it of the greatest importance that there be maintained such accumulations of actual observations and specimens as are represented by the Buitenzorg collections. It is worth recalling that it was while collecting in the Malay archipelago that Alfred Russell Wallace thought out his theories of natural selection and communicated them to Darwin. It does not seem unfair to attribute to the stimulating environment of the Aru islands and their birds of paradise a share in this great biological conception.

It was in Java, we believe, that the rubber tree was first successfully propagated by budding instead of

by seed, and there hybrids of the cinchona with increased quinine content were first developed. The zoological collections in the Buitenzorg Museum are rich and varied, and uncared for in the climate of Java will before long be lost inevitably. They have come from every corner of the far-flung empire of Netherlands' India and represent much rare and priceless material upon which important publications have been based. For the botanist the garden is a wonderland. Here he finds gathered together the giant Rafflesia of Sumatra, the giant bamboos, the immense variety of superb and fascinating orchids, the wealth of insectivorous and myrmecophilous plants, the stinking but delicious Durian, the vast variety of strange and interesting palms which have fascinated the botanists of three generations.

No other institution in the Tropics has accumulated so great a fund of biological information as has Buitenzorg, or kept the priceless materials collected in better condition, most difficult undertaking in a tropical climate.

We are aware that the policy of the Dutch in keeping secret certain discoveries regarding gutta-percha has been criticized, and that there has been criticism too regarding the monopoly of cinchona which has been built up in Java. However, in defense of this policy, it may be said that the discoveries were made at great cost to the Netherlands' Indian government, and have constituted an important source of revenue from which to draw funds for the support of the scientific work carried on there.

These facts, furthermore, being of a political nature, should not prejudice us, as they do not concern the question at issue, which is how to prevent the loss to the scientific world from the collapse of a great center of European learning in the Orient. Every biologist, no matter where he lives, is interested in the conservation of this great scientific center in Java. National lines and national prejudices ought not to enter into the question.

Dr. Dammermann, the present director of the institution, has sent out a straightforward sincere appeal for assistance. The amount asked for is not excessive. No similar garden is maintained so economically as is that at Buitenzorg, owing to the trained staff of Javanese gardeners and laboratory assistants, who are paid the lowest wages ever given to men of such intelligence. When compared with the expenses of maintenance of similar collections elsewhere, the amount appears insignificantly small. Small as it is, however, the situation in Holland is such that help is needed and if not forthcoming, the crisis will soon come. The speed of deterioration of such organizations, when neglected in the Tropics, is amazing. A few months of neglect lead to irreparable losses. The Buitenzorg institution deserves to be tided over into a more prosperous era, or until new sources of income can be devised for its maintenance. It represents a storehouse of knowledge which should not be allowed to disintegrate. What can be done?

DAVID FAIRCHILD
THOMAS BARBOUR

CHEMICAL AND PHYSIOLOGICAL PROPERTIES OF KOJIC ACID

IN a recent study of the metabolism in dogs of the six-carbon derivatives of glucose, a marked toxic action was observed in the case of kojic acid. A definite response was noted after the intravenous injection of 150 mg per kg. The symptoms are copious salivation, retching, vomiting and defecation. The reducing power of the blood is greatly increased. The head begins to nod, the gait becomes unsteady, the animal becomes quieter and may even go to sleep. With larger quantities the animal becomes greatly excited. This is accompanied by continuous yelping and, at intervals, tonic and clonic convulsions. There is marked exophthalmos. Practically the same symptoms are shown by rabbits and rats. The lethal dose of the sodium salt was found to be about one gm per kg.

Kojic acid is formed under certain conditions by molds and aerobic bacteria.[1,2] Maximum yields of 65 per cent. have been obtained from molds by May, Moyer, Wells and Herrick.[3] Kojic acid, like glucose, has the amylene oxide ring structure;[4] but, unlike glucose, this ring is stable. Its acidic properties probably are due to the phenolic hydrogen. It is a pyrone and possesses the properties of other known pyrones. Its copper salt is quite insoluble. It forms a colored iron complex which the writer has observed even at a dilution of 1 to 400,000. The writer finds also that this iron complex can not be reversibly oxidized or reduced. Unlike ascorbic acid (vitamin C), it is not oxidized by iodine in acid solution; but it readily absorbs four equivalents of iodine at pH 6–7. It is further metabolized by molds and yeasts. The writer finds that small quantities injected at two-hour intervals are largely retained and probably burned by the animal.

Its mode of formation under aerobic or partially aerobic conditions, certain of its chemical properties and its marked pharmacological action suggest its possible formation in the tissues of animals in certain pathological conditions, such as epilepsy. Work is

[1] K. Saito, *Botan. Mag.* (Japan), 21: 249, 1907.
[2] T. Takahashi and T. Asai, *Proc. Imp. Acad.* (Tokio), 8: 364, 1932.
[3] O. E. May, A. J. Moyer, P. A. Wells and H. T. Herrick, *Jour. Am. Chem. Soc.*, 53: 774, 1931.
[4] T. Yabuta, *Jour. Chem. Soc.*, 125: 575, 1924.

now in progress in the writer's laboratory along these lines.

THEODORE E. FRIEDEMANN
DEPARTMENT OF MEDICINE
UNIVERSITY OF CHICAGO

SEASONAL EFFECT OF LIME ON STRAWBERRIES

LIME is very essential on the very acid soils of the famous Hammond, Louisiana, strawberry section to carry the plants through the summer. Experiments by A. H. Meyer and B. Szymoniak, of the Louisiana Experiment Station, with various amounts of lime indicate that a pH of 5.0 to 5.5 is best for the dormant season of the strawberry, which is during the hot months of the summer, whereas with lime the plants came through in a vigorous condition. To the contrary, in the cool part of the year, even on the check plats with a pH of about 4.0, the strawberries did well vegetatively. As the strawberries were badly injured in the spring of 1933 by a late frost, no apparent differences were revealed from the yields of the unlimed and limed plats. The dying of the strawberry plant in the summer on the unlimed plats apparently is due to less resistance to aluminum toxicity or else to a greater solubility of the aluminum during the summer.

A. H. MEYER
LOUISIANA STATE UNIVERSITY

SPIRALING IN TREES

I HAVE read with much interest the articles and letters in SCIENCE and in *Nature* during recent years on spiraling in trees. Because all other explanations seem so inadequate I was beginning to consider it an innate and heritable character, this supposition being supported by the fact that the type of spiral found in the trunk is present also in the branches.

However, a few days ago I found a dead tree that was irregularly spiraled. About head high for 3 or 4 feet it spiraled to the right and above that for 5 or 6 feet it spiraled to the left. Still higher up it seemed to be irregular, but I could not be so sure, as more bark was still in place there. The tree was about eight inches in diameter and all in the party agreed that it was some kind of gum tree. Gum wood is notoriously difficult to split, and this may be due to such irregularity of grain.

I found also a dead sapling about 1½ inches in diameter that spiraled to the left. It was quite decayed and on breaking it open found a separate inner core about ⅝ inches in diameter that spiraled to the right. These appeared to be the first and the second year's growth. I could not determine the kind of tree it was. This recalled to my mind that in central India the wood commonly used for furniture and for building purposes has such irregular grain that it can not be planed because whichever way one tries to plane it the plane runs into or against the grain. The native carpenters do not use an ordinary plane bit with a smooth cutting edge but one with the edge of the plane bit finely notched. I did not investigate closely how the grain is arranged, but now I wonder if possibly it may have been due to annual reversal of spiraling.

These irregularities make the inheritance hypothesis of spiraling difficult, but whatever the cause of spiraling may prove to be these irregularities must be taken into account.

Along the Sky Line Drive in Virginia are countless thousands of dead trees that have lost their bark and have been weathered sufficiently to show the grain clearly. This would seem a favorable place to study spiraling.

E. C. L. MILLER
VIRGINIA ACADEMY OF SCIENCE
RICHMOND, VA.

QUOTATIONS

THE NEW MATHEMATICS[1]—A LECTURE BY PROFESSOR BIEBERBACH

IT had appeared hitherto that mathematics, of all the fields of intellectual endeavor, would continue to preserve its neutrality, even in the fiery furnace of the revolution. However, a noteworthy lecture delivered by Professor Bieberbach, the brilliant exponent of function theory and *Ordinarius* at the University of Berlin, before the annual meeting of the *Verein zur Förderung des mathematischen und naturwissenschaftlichen Unterrichts* on Easter Tuesday at the Berlin Technische Hochschule, seems to indicate that the doctrine of blood and race is encroaching even upon this domain and subordinating the most abstract of sciences to the totalitarian state. In this respect, historical significance for developments in the Third Reich may be ascribed to the speech of Bieberbach.

Bieberbach chose as his starting point an actual occurrence, the dispute between the Göttingen student body and Edmund Landau, the famous number theorist, and the stormy rejection of this teacher by the students. This attitude (Bieberbach asserts) is well founded and justified; for the case of Landau shows clearly that there is a German and a Jewish mathematics, two worlds separated by an unbridgeable

[1] Translation of an article appearing in the Sunday, April 8, 1934, issue of the *Deutsche Zukunft*, a German national weekly.

chasm. The selection of problems, as well as their treatment, is characteristic of the thinker and therefore a product of his racial filiation. Landau's style exhibits a haughtiness of spirit and confuses and repels because of its remoteness from reality. To demonstrate his point, Bieberbach chooses as an example the introduction of circular functions and the number π in Landau's new *Einleitung in die Analysis* and contrasts it with the exhaustive method employed by the Aryan mathematician Erhardt Schmidt in handling the same problem. "A people that has found itself can not tolerate such a teacher and must reject foreign thought."

Bieberbach also asserts the existence of such differences between the French mode of mathematical thought and the English-German, and illustrates with a statement of Poincaré's concerning Maxwell, who, however, seemed objectionable to many of his German contemporaries and even to his British countrymen. And Bieberbach touches upon these differences in the introduction of the concept of imaginaries by Gauss, who found satisfaction in intuition, and by the French (Cauchy-Goursat), who stressed the formal aspects. He ingeniously strives to bring his whole argument into accord with Jaensch's psychological theory of types and classifies the French and Latins under the abstractly-thinking S-type, the Germans under the I-type, which is most receptive to reality. "In us Germans the Cauchy-Goursat exposition arouses intolerable displeasure." Naturally not in a Landau. Such a thing is inherent in a person's mental make-up.

Bieberbach's rejection of Landau is cutting in the extreme, a repudiation in the condemnatory style of George. As prototypes of the German-Jewish antithesis in mathematics he cites the two personalities Gauss-Jacobi, Gauss the Saxon as opposed to Jacobi the Oriental, a man of ruthless egotism and intellectual arrogance. While the thought process of Gauss is always deep and clear and inclined to the intuitional and its application, that of Jacobi, on the other hand, is ever wilfully abstract, full of intellectual arrogance and of a diabolical cleverness; in general, a juggling with concepts and an unmistakable craftiness are distinguishing marks of Jewish mathematics. Also Bieberbach makes Jacobi responsible for initiating the separation of pure and applied mathematics. He considers it characteristic of Jewish thought to start from material already at hand and exploit it to the utmost, whereas Aryan thought is genuinely creative. What results is a "dehumanization" of mathematics, estrangement from nature, intuition and practise.

A person familiar with the subject might perhaps venture to offer a few modest objections. He might call attention to Gauss's second proof of the fundamental theorem of algebra, a particularly profound and valuable work which, in reality, is historically the origin of that "dehumanizing" process; he might recall that Gauss himself only reluctantly permitted his official duties as astronomer to divert his attention from his purely theoretical researches, and that Jacobi, who was enthusiastically pursuing his studies in the perturbation theory and in dynamics, had no observatory at his disposal, but only a teacher's chair (he had, however, such astronomical friends as Bessel). Above all, the qualified observer would take into consideration the fact that every mathematician, not only Jacobi, is bound to suffer, if compared specifically with the incomparable Gauss.

Yet, in the following particulars, Bieberbach's conclusions are of more importance. He calls attention to the principle of his teacher Felix Klein, the "Education to Intuition," and contrasts it with the elucidations of the Viennese axiomatist Hahn, according to which a departure from intuition is necessary. Here the opposing type comes into view and the surrender of science to this type is neither necessary nor desirable. There can be no complete mathematical domain independent of intuition and life; the dispute over fundamentals that is now raging is, in reality, a race struggle. "Deep-rooted political implications mold the style of thought."

As far as practical "Kulturpolitik" is concerned, mathematics must be freed from the curse of sterile intellectualism; its weight will fall upon those thinkers, alien to the people and to the race, who will not exist in the future, and whose representatives of the past need no longer be thought of as German research workers. Since German mathematics is rooted in blood and soil, the state may and must support and care for it. The great achievements of German mathematicians of the past and present reveal the science as a forceful manifestation of the national consciousness; and for that reason it needs no further justification. By its method of exposition Bieberbach's representation may perhaps perform a service in the preservation of mathematical activity in Germany and in its salvation in these troubled times.

Much of Bieberbach's exposition suggested a relationship to Schopenhauer's mathematical observations. And, indeed, Bieberbach remarked that he himself had seen a problem readily solved by intelligent laymen, while the scientifically trained mathematician was still immersed in profound meditation. Bieberbach did not mention individuals important for his observations, such as Hermann Minkowski—who, in some respects, might be considered his ideal type—and Georg Cantor. Furthermore, he did not carry his logical conclusions to the point of distinguishing problems and exercises with reference to their racial characteristics.

P. S.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PHOTOELECTRIC APPARATUS FOR TURBIDITY AND LIGHT PENETRATION MEASUREMENT[1]

DURING the past three years many thousands of turbidity and light penetration determinations have been made, both in the field and in the laboratory, by members of the research staff of the U. S. Bureau of Fisheries at the University of Missouri, using a photoelectric set-up, adapting the method of haemolysis measurement of Kesten and Zucker[2] to river water problems. Because of the simplicity of the apparatus, the rapidity with which measurements can be made and the accuracy of the results as shown by various checks on the data obtained, a description of the apparatus is presented below.

A General Electric nitrogen-filled caesium cell, Type P.J. 14, was mounted in a small light-tight black box having a circular opening 40 mm in diameter in line with the target of the cell. This cell box was placed in one end of a second black wooden box $60 \times 30 \times 30$ cms, and the photoelectric cell connected with a portable Ralston micro-ammeter of 30 to 300 range, sensitive to one tenth of a micro-ampere. In the opposite end of the box a Mazda tungsten bulb (25 to 100 watts, depending upon the needs of the work) was mounted behind a partition, in a parabolic reflector so that the reflector projected parallel rays through an opening in this partition 100 mm in diameter, onto the target of the photoelectric cell. The light bulb, which was operated by a heavy duty storage battery to insure uniformity of current (in the field the current can be drawn from battery of car or launch), was placed 30 cms from the target of the photoelectric cell. On the side of the partition in front of the light a carrier, into which glass screens could be mounted when monochromatic light was desired, held a glass-sided container filled with the water to be examined, in the line of parallel rays between the reflector and the target of the cell. For rapid routine turbidity examinations a 300 cc pyrex flask with flat, polished, parallel sides (Kolle flask type), having an inside measurement between the two, flat, polished sides of 25 mm, was used as water container, differences of 0.1 U. S. G. S. units of turbidity being easily detected. For determinations requiring higher accuracy, as sedimentation rates, erosion silt volumes and light penetration limits, a smaller, flat-sided container was constructed by cementing two thin plates of polished glass onto opposite sides of "U"-shaped frame of heavy brass.

Using a distilled water standard, which was considered as 100 per cent. for each combination of bulb and container, the per cent. of light screened out by any sample could be computed, and employing a standard suspension of Fuller's earth[3] for the measurement of water turbidity, calibration curves were readily prepared so that the deflections of the ammeter could be read directly in U. S. G. S. turbidity units.

In the light transmission and color selectivity studies the apparatus was standardized by photographs of the spectra of the light from each bulb and of the light transmitted by each container and Corning glass color screen, made against the helium spectrum.[4] For the interpretation of the data on light penetration the per cent. of light screened out by any given sample was transformed into a penetration-depth value by the following formula:

$$(1) \qquad y = \frac{\log\ (1-x)}{\log\ (1-p)}$$

in which

x = total per cent. of light screened out;
p = per cent. of light screened out by sample as measured by photo-electric cell; and
y = number of times the thickness of the sample in mm (inside measurement of container used) is contained in the depth at which any desired per cent. of light is screened out by the water under consideration.

The curves of light penetration as determined by this apparatus, using distilled water and various monochromatic lights, were found to agree very closely with data published by Pietenpol[5] and the curves given by Shelford.[6] As an additional check on the accuracy of light penetration measurement photographs of the spectra of the light transmitted by various samples of water were compared with the light transmission curves for different wave-lengths obtained from the photoelectric cell readings of monochromatic lights transmitted through these same water samples. The agreement of the spectra with the curves was very satisfactory both in the extent and the selectivity of the transmission.

M. M. ELLIS

U. S. BUREAU OF FISHERIES
UNIVERSITY OF MISSOURI

[1] Published by permission of the U. S. Commissioner of Fisheries.

[2] H. D. Kesten and T. F. Zucker, "The Determination of Rate of Haemolysis by the Measurement of Light Transmission," *Amer. Jour. Physiol.*, 87: 263–273, 1928.

[3] "Standard Methods of Water Analysis." 6th ed., Amer. Pub. Health Association, New York. 1925.

[4] The writer wishes to acknowledge his obligations to Dr. Ray T. Dufford, of the Physics Department, for assistance in standardizing this apparatus, and to Dr. W. D. A. Westfall, of the Mathematics Department, who reviewed the formulae applied to light transmission.

[5] W. B. Pietenpol, "Selective Absorption in the Visible Spectrum of Wisconsin Lake Waters," *Trans. Wisc. Acad. Sci., Arts and Let.*, 19: 562–593, 1918.

[6] V. E. Shelford, "Laboratory and Field Ecology," Williams and Wilkins Company, Baltimore. 1929.

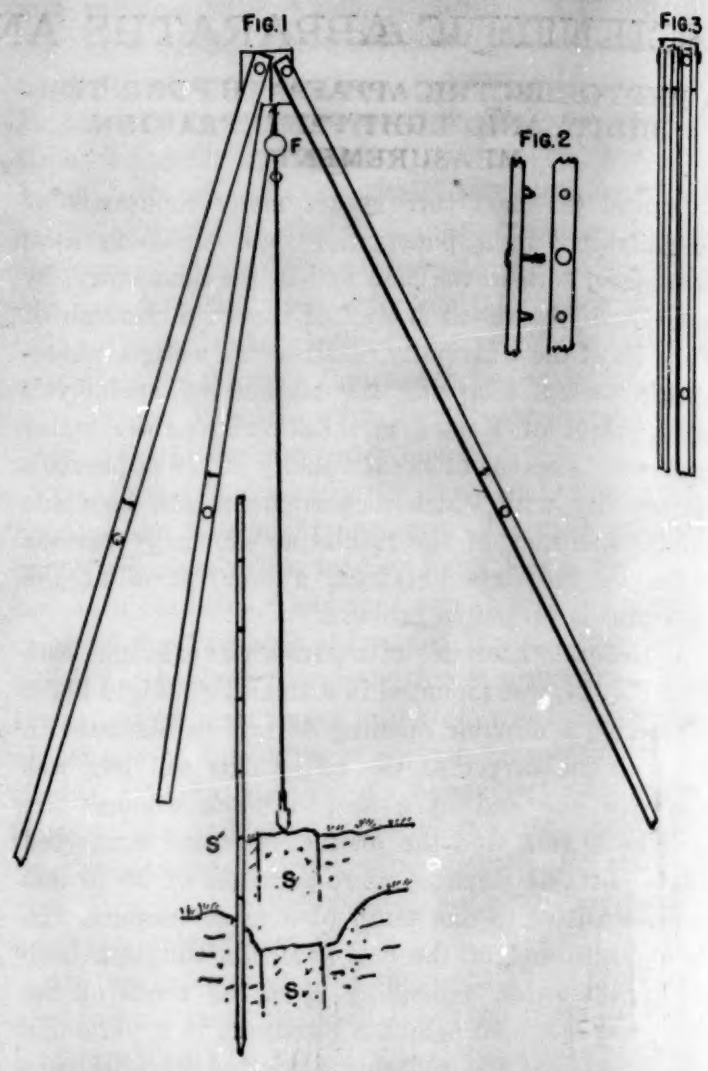
A LOW-PRICE STATION INDICATOR

IN surveying rather accurately limited private or company holdings one frequently feels the need of some device for use as a temporary target where ordinary ranging poles are quite unsatisfactory—unsatisfactory for two reasons: First, modern asphalt, paving and surfacing work in general as well as permanent rock, concrete or metal markers do not permit of driving in a sharpened flag-pole at the exact station center; and second, if off center, as shown by S′, Fig. 1, near a station S, visible or depressed below the reach of the plow, the transitman can make use of it in but one position, *viz.*, when he, station S and rod S′ are exactly in line, otherwise grave errors are introduced.

A long-legged, home-made tripod helps matters out greatly and saves more than its cost in a few hours' work.

Take a triangular prism 4 to 6 inches long and to each face bolt a slat ⅝ in. thick, by 1 to 1½ wide and seven or eight feet long, as indicated by Fig. 1. These slats may be jointed so as to fit tightly together and fold as indicated in Figs. 2 and 3. Nuts with wings should be selected. A screw hook and plummet are for objects self-explanatory. As the "bob" is too near the ground for convenience in sighting, a hollow rubber ball, F, may be slipped over the plumbline and will stay put at any desired elevation, the higher the better for observation and eliminating pendulous movements of the "bob."

The upper portion of this tripod when painted white is very conspicuous and easily picked up by the telescope, while the white plummet, or the rubber



sphere if painted white or red and white serve for refined sighting.

The cost of material and labor is $3.00.

G. D. HARRIS
CORNELL UNIVERSITY

SPECIAL ARTICLES

LIGHT IN RELATION TO DORMANCY AND GERMINATION IN LETTUCE SEED

THE light-sensitivity of prepared photographic film is now so familiar as to be rated a commonplace; but that an exposure of a few seconds may mean the difference between no germination and complete germination in moist lettuce seed has only recently been appreciated through the studies here reported. Since "dormant" lettuce seed so exposed to light may be germinated in 24 hours in distilled water the material proves to be unusually well adapted to the study of light as a potential factor in "dormancy" and germination.[1]

The following results obtained with a 60-watt Mazda bulb as a source of light indicate some of the general characteristics of light in relation to the germination of "dormant" lettuce seed:

(1) ATTAINMENT OF MAXIMUM SENSITIVITY TO LIGHT

Variety: Big Boston
Culture medium: Water
Temperature: 25° C.
Illumination: 600 foot-candle minutes.

Time of soaking in minutes	Percentage germination
10	20.3
30	53.8
50	62.1
60	66.7
80	74.6
100	90.5

[1] In July, 1933, at a meeting of the Association of Official Seed Analysts of North America, A. L. Shuck presented a paper in which it was stated that the beneficial effect of presoaking "dormant" lettuce seed at low temperatures was largely due to light rather than to soaking.

(2) EFFECTIVENESS OF ILLUMINATION AT TIME OF MAXIMUM SENSITIVITY TO LIGHT

Variety: Arlington Fancy
Culture medium: Water
Temperature: 20° C.
Presoaking: 2 hours
Light exposure: 1 minute.

Foot-candle-minutes of illumination	Percentage germination
2	0
8	7
32	37
64	54
128	73
512	84
2048	86

(3) RELIABILITY OF THE TIME-INTENSITY PRODUCT IN ILLUMINATION

Variety: Arlington Fancy
Culture medium: Water
Temperature: 20° C.
Presoaking: 2 hours.

Illumination in foot-candles	Time of exposure in minutes	Percentage germination
64	1	53.5
32	2	52.8
16	4	54.5
8	8	58.1
4	16	47.5
2	32	58.2

The following results were obtained with sunlight:

Variety: Arlington Fancy
Culture medium: Moist paper
Temperature: 20° C.
Presoaking: 2 hours
Illumination: 1200 foot-candles

Time of exposure in seconds	Percentage germination
0	0
60	99
15	97.9
4	97.5

The above results suggested that sunlight was perhaps more effective than electric light in promoting germination and attention was directed to the quality of light. In carrying out further studies the longer wave-lengths of the visible spectrum, characterizing red, orange and yellow light, were found to be the ones effective in promoting germination. The shorter wave-lengths of the visible spectrum, characterizing violet, blue and green light, were found to be not only ineffective in promoting germination, but definitely effective in inhibiting germination.

The following results were obtained with filters, using a 60-watt Mazda bulb as a source of light and a Weston photronic cell for measuring illumination:

(1) QUALITY OF LIGHT IN RELATION TO GERMINATION

Variety: Arlington Fancy
Culture medium: Water
Temperature: 25° C.
Light: Continuous exposure at 3 foot-candles.

Wratten filter numbers	Color	Effect on germination
23, 24, 25, 26, 27, 29, 30, 31, 32, 33	Red	Promote equally well
15, 16, 21, 22, 23a	Orange	Promote equally well
3, 6, 7, 8, 9, 12	Yellow	Promote equally well
64, 67	Green	Promote equally well
44, 55, 56, 57, 57a, 58, 59, 59a, 60, 61	Green	No germination
38, 44a, 45, 46, 47, 48, 48a, 49, 50	Blue	No germination

(2) INHIBITORY EFFECT OF BLUE LIGHT ON GERMINATION

Variety: Arlington Fancy
Culture medium: Water
Temperature: 25° C.
Continuous light.

Foot-candles red light only	Percentage germination	Foot-candles red light +	Foot-candles blue light	Percentage germination
1	90.3	1	2.1	0
2	80.4	2	2.0	0
3	88.6	3	1.6	7.14
4	84.8	4	1.4	11.5
5	91.4	5	0.9	50.7
6	89.0	6	0.2	68.0

With the establishment of a definite light-sensitivity for so-called "dormant" lettuce seed, the question arose as to whether or not the "dormancy" could be broken by exposing moist seed to favorable wave-lengths of light independent of germination. A series of tests was carried out in which light-sensitive seed was soaked for two hours, exposed to a light for a sufficient time to insure germination, and then dried out. It was found that seeds so treated would germinate readily several weeks thereafter without light—in other words, the "dormancy" could be broken by a light treatment, after which the seeds would respond to the conventional methods designed for the germination of "non-dormant" seed. The possibility of making a practical adaptation of such a light treat-

ment to large lots of "dormant" seed is so obvious as to require no emphasis.

With the establishment of a definite inhibitory action for blue light it became of interest to try to induce light-sensitivity (in this case also a so-called "dormancy") in normal or non-light-sensitive lettuce seed by subjecting moistened seed to blue light for a time and then drying it out. A series of such tests was carried out in which it was found that normal or non-light-sensitive lettuce seed could be made light-sensitive by subjecting it when moist to a strong blue light. Seed so treated would not germinate in darkness, but would germinate under red light, or by suitable exposure to red light and drying could be again rendered normal or "non-dormant" or non-light-sensitive. The reaction involved in the above procedure is thus reversible, but no attempts have been made as yet to localize or identify the material or materials responsible for the action.

LEWIS H. FLINT

BUREAU OF PLANT INDUSTRY
U. S. DEPARTMENT OF AGRICULTURE

THE PREVALENCE OF STREPTOCOCCUS BACTERIOPHAGE

THE subject of bacteriophage, the lytic principle which destroys bacteria, is of special interest to bacteriologists, but it is of general interest to all biologists. Hence this report is offered to SCIENCE.

The general interest in bacteriophage lies in the hope that a solution of the problems in regard to its nature may contribute something to an understanding of the great mystery of life. The study of bacteriophage promises to enlighten the philosophical consideration because it stands at the border line between catalytic chemical substances, on the one hand, and living matter, on the other.

If bacteriophage be regarded as an enzyme it must be conceded that it is endowed with at least one of the attributes of living matter—a limited ability for adaptation to its environment. On the other hand, the minute size of the individual particles offers an obstacle to the acceptance of the idea that they may be living organisms. It has been shown that they may be no larger than certain protein molecules. They are so small that ten or even a hundred billion individuals may exist in a cubic centimeter of broth which nevertheless remains as clear as crystal. In this communication no attempt is made to add weight to either side of the argument as to whether or not bacteriophage should be regarded as living matter, except in so far as new information on one particular aspect of bacteriophage may contribute to a general understanding of the subject.

Although it is known that bacteriophage specific for intestinal bacteria may be readily isolated from sewage, the belief is common that streptococcus bacteriophage is rare and difficult to obtain. In his recent review of the literature on bacteriophage Burnet[1] concludes that it is extremely rare to obtain a phage active against streptococci. He mentions the race which was isolated by Clark and Clark[2] as the only indubitable streptococcus phage on record. It will be referred to here as the "Wisconsin" phage.

The writer studied the streptococcus phage in commercial preparations and found that a second race has been distributed to various laboratories in this country, although it has been merely mentioned in the literature.[3] This second race was isolated in 1928 by Dr. Pearl Kendrick, of the Michigan Department of Health, from the feces in a case showing intestinal hemorrhages. It will be referred to as the "Michigan" phage.

A third race was isolated by the writer in April, 1933, from a sample of sewage received from Cincinnati. This race, designated as the "Cincinnati" phage, was recently reported briefly.[4]

The 3 phages were found to be useful in a study of the relationships of hemolytic streptococci. The collection on which this study is being made consists of over 300 strains from wide geographical sources and from all kinds of streptococcus infections of man and domestic animals. Some of the strains were found to be sensitive to one of the races of phage, some to another and some were sensitive to two or all three of them. In general, when several strains from a given epidemic were available, they were found to agree in their sensitivity to the 3 phages. Thus it became apparent that sensitivity or resistance to several races of phage offers a characteristic useful for the identification of hemolytic streptococci.

One rather large group of streptococci was characterized by failure to show sensitivity to any except the "Wisconsin" phage, which under certain conditions is capable of attacking about 97 per cent. of strains of human origin. It seemed desirable to find another race of phage which might attack the strains of this group, in order to give the group a more distinctive character. The readiness with which streptococcus phage was found in the samples of sewage examined is so contrary to its reported rarity that it seemed worth while to record the observations.

The group of streptococci for which a phage was

[1] F. M. Burnet, "Bacteriophage and Cognate Phenomena," in "A System of Bacteriology," Vol. 7, London, pp. 463–509, 1930.

[2] Paul F. Clark, and Alice Schiedt Clark, "A Bacteriophage Active against a Virulent Hemolytic Streptococcus," *Proc. Soc. Exp. Biol.*, 24: 635–639, 1927.

[3] Pearl Kendrick and Harriet C. Hollon, "Serologic and Bacteriophagic Relationships in a Group of Fecal Streptococci," *Jour. Bact.*, 21: 49–50, 1931.

[4] Alice C. Evans, "Streptococcus Bacteriophage and Its Usefulness for the Identification of Strains of Hemolytic Streptococci," *Ibid.*, 27: 49–50, 1934.

sought contained, among others, strains from several epidemics of septic sore throat which occurred in Massachusetts and Connecticut within recent years. Therefore it was logical to search for the desired phage in sewage from cities of those states during the season when streptococcus infections are prevalent. I am indebted to the health officers of Boston and Hartford for the two samples of sewage examined. Both were received in January, 1934. The examination of the two samples was made simultaneously.

TECHNIQUE

The technique was similar to that commonly employed to obtain from sewage phages active against other species of bacteria. The medium was meat infusion broth of double strength, which was distributed in test tubes, sterilized by heat and then diluted with an equal quantity of sewage from which all bacteria were removed by filtration. To this medium 25 per cent. of sterile filtrate was added from cultures as described below.

For the first culture generation of streptococci the filtrate added to the sewage medium was from culture planted with the unfiltered sewage, and incubated overnight at 37° C. The inoculum for this first culture generation of streptococci was with a mixture of 10 strains. A very light inoculum was prepared by adding one drop of over-night culture of each of the strains to a tube containing about 10 cubic centimeters of broth, and planting one drop of this diluted mixed culture in the sewage medium. After growth over night the culture was filtered, and the filtrate was tested to demonstrate any lytic principle it might contain by planting each of the 10 strains in pure culture into broth containing 10 per cent. of the filtrate.

For the second and following culture generations in the sewage medium inoculations were made with the 10 strains in pure culture, while the filtrate added to the medium was a mixture of filtrates from the 10 preceding pure streptococcus cultures. The lot of 10 streptococci was made up of representative strains from the group for which a new phage was sought.

A weak lytic principle appeared in the filtrate of the third culture generation in the medium containing the Boston sewage. The procedure was continued, using now only 3 or 4 of the most sensitive streptococcus strains of the lot. It required only a few more such passages to attain what appears to be the maximum potency for this race of phage—the ability to lyse sensitive strains in a dilution of about 1 to 10^6.

This new race, designated the "Boston" phage, is not neutralized by any one of the 3 serums specific for the Wisconsin, Michigan or Cincinnati races of phage. (Anti-phage serum is prepared by treating rabbits repeatedly with the phage for which the antibody is desired.) Hence there are now 4 antigenically distinct races of streptococcus bacteriophage available for study.

Both the Boston and the Hartford samples of sewage were further examined for the presence of a phage similar to the Cincinnati race. The procedure was as outlined above, except that the 10 selected strains of streptococci were all sensitive to the Cincinnati phage. A lytic principle appeared in the filtrates from the first generation of the mixed streptococcus culture in both the Boston and Hartford media. Both lysates were active against the same strains of streptococci as the Cincinnati phage, and both were neutralized by the serum of a rabbit treated with the Cincinnati phage. According to these criteria both races are identical with the Cincinnati phage.

The readiness with which bacteriophage was obtained from the Boston and Hartford samples of sewage indicates that streptococcus bacteriophage is widely distributed, at least during the season when streptococcus infections are prevalent.

ALICE C. EVANS

NATIONAL INSTITUTE OF HEALTH
WASHINGTON, D. C.

EFFECTS OF PROTRACTED EXPOSURE TO A LOUD TONE[1]

WITHIN recent years, Yoshii and others have published evidence which purports to show that protracted exposure of animals to intense tonal stimulation results in localized cochlear lesions whose foci are dependent upon the exposure-frequencies.[2] More recently, Upton attempted to determine the functional effects of exposing guinea pigs to a 1,000-cycle tone, and reported marked loss of acuity to the exposure frequency but no loss at 500 cycles.[3] These results have been widely accepted and are commonly interpreted in favor of the resonance-hypothesis. The methods employed do not always carry conviction, however, particularly in the crucial matter of measuring what the animal actually can, and can not, hear. The indicators by which the animal reveals that it hears a given tone (usually some form of startle-behavior, *e.g.*, pinna- or breathing-reflex) are notoriously subject to extinction by the very condition of long-continued exposure to that tone; hence we

[1] Communication No. 5 from the Alpha Research Laboratory, Department of Psychology, established and maintained with aid from the Research Trustees, American Otological Society. Special aid in this problem from the Elizabeth Thompson Science Fund is gratefully acknowledged.

[2] For references, see C. v. Eicken, *Abderhalden's Handb. d. biol. Arbeitsmethoden*, v: 771, 1929.

[3] M. Upton, "Functional Disturbances of Hearing in Guinea Pigs after Long Exposure to an Intense Tone," *Jour. General Psychol.*, 2: 397–412, 1929.

can seldom be sure whether animal's failure to respond is due to actual inability to *hear* that tone or due merely to extinction of the overt response. We have long been convinced that this problem, whose importance for questions of general auditory theory is commonly admitted, merits systematic re-examination; and the results hitherto obtained tend to confirm this conviction.

The actual acuity of a female dog A was measured by an established form of the conditioning procedure[4] at nine separate frequencies from 200 to 5,000 cycles. She was then exposed to a continuous 1,000-cycle tone (whose energy-level was about 110 decibels above her limen) for 18 hours within the space of five days. Her acuity was then found to have fallen by forty to fifty decibels, not at 1,000-cycles alone but throughout the entire test-range (Table I, row 2). Her limens remained virtually the same, despite continuance of the exposure, for an additional period of 8 days. Then, in hope of achieving still greater loss, we *interrupted* the exposure-tone 52 times a minute (each burst of sound continuing about 0.12 second). After 15 hours of this intermitted sound within the course of a single day, hearing was further reduced about thirty decibels (row 3), whereupon it again remained virtually level, except for a slow recession. When 148 hours of interrupted stimulation (distributed through 11 days) had been completed, all exposure was terminated. The animal was soon thereafter dispatched and preliminary steps for histological examination begun.

TABLE I

(1) Frequency	200	500	800	900	1000	1100	1200	2000	5000
(2) Loss in decibels after 81 hours continuous tone	49	38	52	46	48	48	49	36	53
(3) Total loss in db. after 148 hours interrupted tone	71	80	85	80	81	84	83	76	83

To make sure that this great reduction was not due in whole or in part to mere extinction of the conditioned response (flexion of right foreleg), whereby we test animal's ability to hear, we placed dog B under *complete general anesthesia* (Nembutal) during each exposure-time of ten hours. Inasmuch as the animal "slept" peacefully through the whole exposure, the response-mechanisms which had been conditioned into the higher neural centers were presumably shielded from disruption, whereas the peripheral acoustic apparatus was being affected much as usual. An interrupted tone of 3,000-cycles (intensity about 110 db. above B's limen) was used, and exposure continued for five 10-hour stages. Table II shows the loss in acuity after each of these 10-hour periods.

TABLE II

Cumulative exposure	Test frequencies							
hours	500	1000	2000	2500	3000	3500	4000	5000
10	33	20	40	32	33	30	25	17
20	46	47	59	60	55	62	59	55
30	67	56	70	71	70	71	75	72
40	59	49	74	79	73	78	78	71
50	56	47	77	79	72	78	78	71

Thirty-one days after the last exposure, B still shows no signs of recovery from the levels reached directly after the final exposure.

Several conclusions seem to emerge from these observations:

(1) Protracted stimulation by loud tones of medium pitch (1,000 and 3,000 cycles) induces an almost *horizontal subsidence* in auditory acuity throughout an extensive section of the audible range.

(2) No sign of functional restoration appears as much as thirty-one days after the last exposure.

(3) The *interrupted tone* proves to be an extremely effective instrument for acoustic impairment. It is well known that a steel bar, when exposed to repeated stresses of appropriate force, fails sooner than under a dead load of the same magnitude; analogous principles may be operative here. Certainly these recurrent bursts of sound are more distressing to the human ear than is a continuous tone of the same amplitude.

Until histological examination is effected, any theoretical inquiry would be premature. Several explanatory possibilities may be noted: (1) Wide-spread cochlear lesions; (2) middle ear effects, such as spastic degeneration of the tensor tympani; (3) even coagulation of proteins in the cochlear perilymph might be suggested.

GLEN FINCH
ELMER CULLER

UNIVERSITY OF ILLINOIS

[4] For description of training and testing technique, see SCIENCE, 78: 269–270, 1933.

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